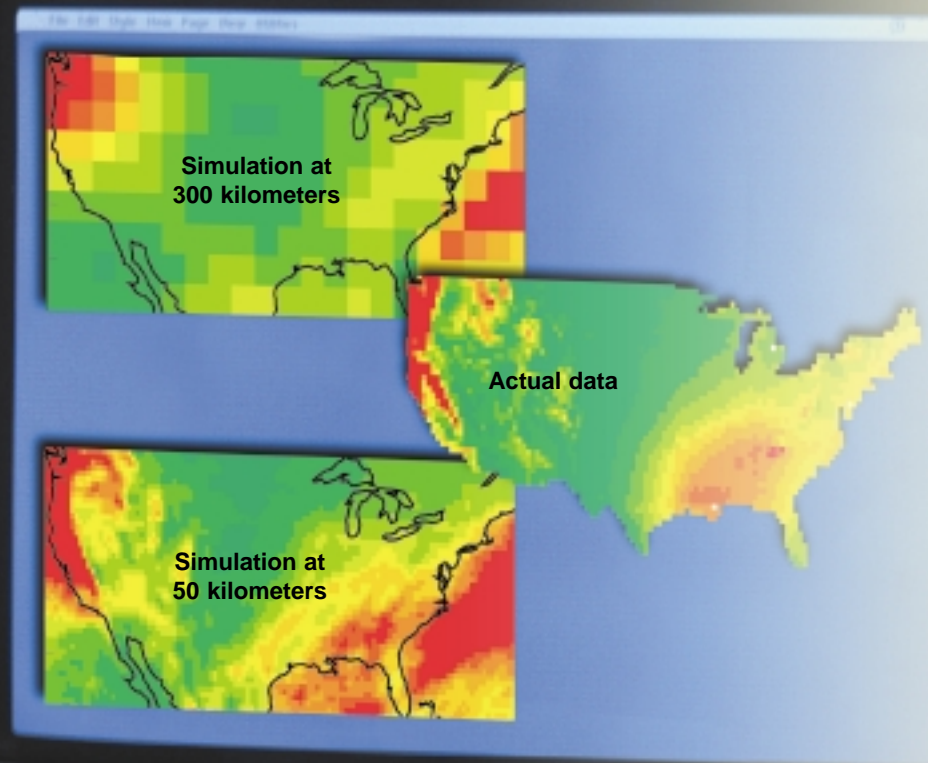


Preserving the Environment and Managing Carbon



Environmental expertise at the Laboratory arose from the need to understand the consequences of nuclear testing—in the atmosphere and underground. Today, geophysicists are developing innovative tools to characterize and mitigate groundwater contamination and manage nuclear waste. Atmospheric scientists are prepared to assist in the event of hazardous material releases to the atmosphere. They are also improving simulation models to understand the climatic consequences of human activities that produce carbon dioxide and other greenhouse gases.

Improving Global Climate Simulation Models

In 2001, Livermore researchers made significant progress applying and further developing global climate simulation models. Because of computational limitations, models today are typically run at 300-kilometer spatial resolution, which does not adequately represent smaller-scale topographic features, such as the Sierra Nevada in California. The results are realistic on a large scale; however, the models do not always accurately simulate climate at regional scales. The modeling results provide an insufficient basis for assessing potential societal effects of climate change (for example, water management and effects on agriculture) in regions such as California's Central Valley.

Taking advantage of terascale computer resources at Livermore, researchers successfully performed global climate

simulations at a much finer resolution (50 kilometers) than ever attempted before. As expected, these high-resolution simulations, requiring roughly 200 times more time and 35 times more memory than 300-kilometer simulations, produce much more realistic regional climates. Simulation results of winter rainfall over 10 years are illustrated and compared with actual data.

Another limitation of current models is that atmospheric carbon dioxide (CO₂) concentrations are prescribed, not simulated. Earth's large natural sources and sinks of carbon interact with the man-made emissions and affect CO₂ accumulation. A better model would simulate the global carbon cycle and predict time-evolving concentrations of greenhouse gases using man-made emissions as input.

Livermore researchers are developing such a global-scale model—the integrated climate- and carbon-cycle (INCCA) model. To make rapid progress, they are using existing, well-documented models of the atmosphere, ocean, land surface, and aerosol chemistry. The individual models are being integrated into the INCCA system and modified where necessary for use on terascale computers. In 2001, models from the National Center for Atmospheric Research and the University of Wisconsin were acquired and tested. In the coming year, researchers expect to complete the coupling of the full climate and carbon-cycle system. They will then be able to pursue comprehensive predictive simulations, which can be used to evaluate the climatic effect of proposed energy policies.

1950s



In the late 1950s, a Laboratory researcher constructed the first global general circulation model, able to simulate the behavior of large weather systems. Concerns about nuclear winter heightened interest in global circulation models in the 1980s, and in the 1990s, steadily improving models provided evidence of human-induced climate change.

1960s



Interest in the peaceful use of nuclear explosives (Project Plowshare) led to the development of models to accurately estimate fallout, and studies were conducted of the environmental impact of proposed nuclear-excavation projects. Activities in the 1970s evolved into continuing efforts toward helping Marshall Islanders resettle.

1970s



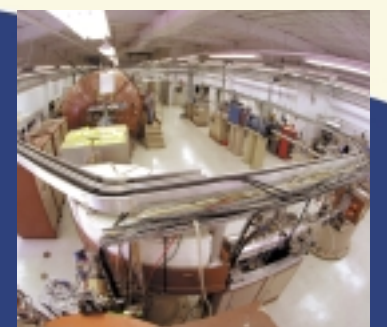
The Laboratory proposed to DOE the establishment of the National Atmospheric Release Advisory Center (NARAC) at Livermore. NARAC became responsible for estimating the fate of radionuclides in the event of actual or potential releases. During pilot operations in 1979, the center was called for assistance after the Three Mile Island incident.

1980s



Livermore researchers developed innovative modeling techniques and technologies for characterizing and remediating groundwater beneath the Laboratory, which had been earlier contaminated by the disposal of hydrocarbons. The techniques are being applied to clean up the Laboratory and Superfund sites elsewhere.

1990s



The Center for Accelerator Mass Spectrometry (CAMS) began operations in 1989 and now processes nearly 30,000 samples per year for users. Able to detect one particular atom out of a quadrillion, CAMS supports projects that range from archaeological dating to biomedical research and from global climate change to national security.